INDEX to Volume 77

January, 1989, pages 1-120 **February,** 121-232 **March,** 233-344
April, 345-456 **May,** 457-576 **June,** 577-688

Titles

Baffling Ring Arcs of Neptune, The, *André Brahic* and *William B. Hubbard,* 606
Best Telescopic Pictures of Mars, The, *Gérard de Vaucouleurs,* 15
Big One Is Coming! The, *Leif J. Robinson,* 134
Chaucer and the Moon's Speed, *Donald W. Olson* and *Laurie E. Jasinski,* 376
Crashing Galaxies, Cosmic Fireworks, *William C. Keel,* 18
Drawing Mars from Video, *Roger N. Clark,* 476
Enigmatic Triton and Nereid, *Andrew M. Thorpe,* 484
Ever-Vigilant GNAT, The, *David L. Crawford,* 143
Field Guide to Atmospheric Optics, A, *Fred Schaaf,* 254
Great Balls of Fire, 494
Looking Ahead to Neptune, *David J. Stevenson,* 481
Looking into the Big Bang, *David H. Smith* and *Alan MacRobert,* 593
Make a Telescope for $500: Model 2, *Sherman Schultz,* 26; Model 3, *John N. Mitton,* 488
Mars' Grand Finale, *Donald C. Parker, Jeff D. Beish,* and *Carlos E. Hernandez,* 369
Memorials on the Moon, *Harold Masursky* and *Mary Strobell,* 265
Neptune Through the Eyepiece, *Stephen James O'Meara,* 486
Neptune's Forgotten Ring, *Richard Baum* and *Robert W. Smith,* 610
New, Improved Space Telescope, The, *Richard Tresch Fienberg,* 153
Observatory at 90° South, An, *David H. Smith,* 598
Olbers' Paradox Solved at Last, *Paul S. Wesson,* 594
Planet Next Door, The, *Aleksandr T. Bazilevskiy,* 360
Planets' Magnetic Environments, The, *Louis J. Lanzerotti,* 149
Red Planet Shows Off, The, *Jeff D. Beish, Donald C. Parker,* and *Carlos E. Hernandez,* 30
Reminiscences of the 300-foot, *Gerrit L. Verschuur,* 252
Results of the July Moonwatch, *LeRoy Doggett* and *Bradley Schaefer,* 373
Sizing Up Phobos, *Philip J. Stooke,* 477
Sky-Gazer's Almanac 1989, 59
Small-Scale Telescope, *William L. Gould,* 250
SN 1987A and Its Ultrafast Pulsar, *Ronald A. Schorn,* 480
What's New on Mars? *William K. Hartmann,* 471
Whence Come Comets? *Armand H. Delsemme,* 260
Who First Saw the Zodiacal Light? *Donald W. Olson,* 146

Authors

Albrecht, Richard E., The Design of Telescope Structures — I, 97; II, 210
Allen, David, book review, 502
A. M., see *MacRobert, Alan*
Anderson, Jay, solar eclipse weather previews, 134, 136
Arnold, H. J. P., Portrait of a Year, 678
Baum, Richard, and *Robert W. Smith,* Neptune's Forgotten Ring, 610
Bazilevskiy, Aleksandr T., The Planet Next Door, 360
Beish, Jeff D., Donald C. Parker, and *Carlos E. Hernandez,* The Red Planet Shows Off, 30
see also *Parker, Donald C.*
Bless, Robert C., Space Station *Freedom:* Bad News for Astronomy, 460
Bock, Paul H., Jr., letter, 581
Bortle, John E., Comets This Month, 407
Sungrazing Comets: Big and Small, 564
Brahic, André, and *William B. Hubbard,* The Baffling Ring Arcs of Neptune, 606
Brasch, Klaus R., letter, 125
Briggs, John W., letter, 238
Brooks, Edward M., solar eclipse weather previews, 134, 136, 138, 139
Byrd, Deborah, book review, 38
Cervenko, Frank, letter, 583
Chandler, Kenneth N., A "Lift-Off Roof" Observatory, 96
Clark, Roger N., Drawing Mars from Video, 476
Cornell, James, Cosmic Correspondence, 348
Correa, Odilon Simoes, Jupiter and Its Mobile Moons, 650
Coyle, Harold P., China: Astronomy in a Redeveloping Nation, 199
Crawford, David L., The Ever-Vigilant GNAT, 143
Cruikshank, Dale P., letter, 583
D. di C., see *di Cicco, Dennis*
Delsemme, Armand H., Whence Come Comets? 260
de Pontieu, Bart, letter, 126
de Vaucouleurs, Gérard, The Best Telescopic Pictures of Mars, 15
di Cicco, Dennis, Running on Batteries, 266
Tuesday's Mail, 111
Watching Mars' Elusive Moons, 446
Doggett, LeRoy, and *Bradley Schaefer,* Results of the July Moonwatch, 373
Dunham, David W., Crescent Moon Nicks the Pleiades, 405
Lunar Occultation Highlights for 1989, 68
Planetary Occultations of Stars in 1989, 70
Dunham, David W., Carolyn C. Porco, and *Douglas J. Mink,* Saturn To Occult a Bright Star, 638
Dyer, Alan, In Defense of Casual Astronomy, 580
Entrop, Hubert A., Photographing the Deep Sky Amid City Lights, 108
Fairall, Anthony P., book review, 382
Fienberg, Richard Tresch, The New, Improved Space Telescope, 153
Fraknoi, Andrew, letter, 238
Fried, Bart, H. B. Rumrill: An Amateur's Legacy, 86
Gavin, Maurice, The Crawford-Dobsonian Mounting, 327
Gee, Alan E., book review, 614
George, Alvin D., Washington Public Observatory Expands, 657
Goldsmith, Donald, book review, 162
Gordon, Rodger W., letter, 582
Gould, William L., Small-Scale Telescope, 250
Graham, Francis G., letter, 350
Greenstein, George, book review, 613
Guest, Elwyn A., letter, 5
Haggman, Bertil, letter, 6
Harrington, Phil, A Bowl Full of Galaxies, 444
Hartmann, William K., Mars from Mauna Kea, 474
What's New on Mars? 471
Hazen, Martha L., letter, 125
Hernandez, Carlos E., see *Beish, Jeff D.;* and *Parker, Donald C.*
Hibble, Robert C., letter, 581
Hicks, Robert D., Affecting Eternity, 236
Houston, Walter Scott, Deep-Sky Wonders, 114, 227, 338, 450, 570, 683
Hubbard, William B., see *Brahic, André*
Hunter, Tim B., M.D., An Observatory from a Kit, 492
Ilyas, Mohammad, letter, 349
Jasinski, Laurie E., see *Olson, Donald W.*
Job, Robert, Help for Star-Atlas Fumblers, 420
Kammerer, Andreas, The Double Polestar of the Past, 531
Keel, William C., Crashing Galaxies, Cosmic Fireworks, 18
Keene, George T., letter, 350
Kirshner, Robert, book review, 39
Koehn, Larry, Mars from Tennessee, 676
Kramer, Jack, letters, 125, 582
Krisciunas, Kevin, book review, 380
Kurczewski, Eric, letter, 582
Lai, Luciano, How I Made a Schmidt Camera, 664
Lanzerotti, Louis J., The Planets' Magnetic Environments, 149
Larson, Stephen M., book review, 36
Interpreting CCD Images of Mars, 472
Lecacheux, Jean, letter, 349
Levy, David H., letter, 6
StarTrails, 88, 203, 319, 432, 548, 659
Lindley, David, book review, 159
Livingston, William C., book review, 271
Lopriore, Gennaro R., letter, 581
Lovi, George, book review, 40
Rambling Through the Skies, 57, 175, 287, 399, 515, 629
Maclean, A., letter, 126
MacRobert, Alan, book review, 39
A 1989 Planet Preview, 66
A Star-Hop from Capella, 140
A Star-Hop Through Ophiuchus, 603
see also *Mitton, Jaqueline;* and *Smith, David H.*
Madea, Jan, letter, 462
Maran, Stephen P., book review, 156
Martin, Franklin D., Let *Freedom* Ring! 460
Masursky, Harold, and *Mary Strobell,* Memorials on the Moon, 265
Mathias, O. Boyd, A Simple Mount for the C90 Telescope, 441
McDowell, Michael, letter, 349
Merope, Deedra, letter, 6
Michaud, Michael A. G., Cooperation in Space: The Real World, 4
Miller, Richard W., letter, 237
Mink, Douglas J., see *Dunham, David W.*
Mitton, Jacqueline, and *Alan MacRobert,* Colored Stars, 181
Mitton, John N., Make a Telescope for $500: Model 3, 488
Moga, Thomas Traian, So . . . You've Had a Bright Idea! 324
Morales, Ronald J., book review, 498
Morrow, Michael, see *Terry, Robert*
Mosley, John, Review Corner, 82, 422, 533
Murphree, Robert W., letter, 6
Nichols, Robert G., Magellan's Journey Begins, 367
Odenwald, Sten, Turning Pro: The Good, the Bad, and the Ugly, 124
Oliver, Bernard M., letter, 125
Olson, Donald W., Who First Saw the Zodiacal Light? 146
Olson, Donald W., and *Laurie E. Jasinski,* Chaucer and the Moon's Speed, 376
O'Meara, Stephen James, Jack Horkheimer: "Star Hustler," 544
Neptune Through the Eyepiece, 486
Women in Astronomy, 317
Page, Brian R., letter, 581
Parker, Donald C., Jeff D. Beish, and *Carlos E. Hernandez,* Drawing Mars in 1988, 429

Mars' Grand Finale, 369
see also *Beish, Jeff D.*
Pitcairn, Douglas, letter, 237
Poani, Ernie, letter, 581
Porco, Carolyn C., see *Dunham, David W.*
Prentice, Gary S., letter, 126
Preston, Sandra, letter, 582
Priester, Wolfgang, letter, 462
Reiland, Tom, letter, 583
Robinson, Leif J., The Big One Is Coming! 134
R. W. S., see *Sinnott, Roger W.*
Schaaf, F., A Field Guide to Atmospheric Optics, 254
Schaefer, Bradley E., Dating the Crucifixion, 374
How Faint Can You See? 332
letter, 349
Refraction by Earth's Atmosphere, 311
see also *Doggett, LeRoy*
Schorn, Ronald A., book review, 501
Picking Up the Pieces, 252
SN 1987A and Its Ultrafast Pulsar, 480
Schultz, Sherman, Make a Telescope for $500: Model 2, 26
Sharples, Thomas D., letter, 5
Shoemaker, Eugene M., letter, 5
Sinnott, Roger W., Continued Fractions and the Sky, 80
Two Arms Are Better Than One, 436
S. J. O., see *O'Meara, Stephen James*
Sledge, John, letter, 582
Smith, Alex G., book review, 612
Smith, David H., An Observatory at 90° South, 598
Smith, David H., and *Alan MacRobert,* Looking into the Big Bang, 593
Smith, Franklin W., letter, 237
Smith, Robert W., see *Baum, Richard*
Stevenson, David J., Looking Ahead to Neptune, 481
Stooke, Philip J., Sizing Up Phobos, 477
Strobell, Mary, see *Masursky, Harold*
Taki, Toshimi, A New Concept in Computer-Aided Telescopes, 194
Tardif, Alphonse, The Amazing Stepper Motor, 554
Taylor, Peter O., Watching the Sun, 220
Terry, Robert, and *Michael Morrow,* letter, 349
Terzian, Yervant, book review, 157
Thorpe, Andrew M., Enigmatic Triton and Nereid, 484
Toone, John, New Dwarf Nova Soon To Erupt? 404
Tuthill, Roger W., letter, 6
Tynemouth, Robert, letter, 462
Valcourt, Richard J., letter, 237
Vaning, Walker, letter, 6
Verschuur, Gerrit L., A Green Flash of Jupiter, 259
Reminiscences of the 300-foot, 252
Washburn, Mark, book review, 268
Wen Xueshi, Beijing: Projecting into the Future, 201
Wesson, Paul S., Olbers' Paradox Solved at Last, 594
Whitney, Charles A., letter, 237
Will, Clifford M., book review, 383
Wood, Charles A., book review, 270
Young, Graham, letter, 583

Departments and Features

Amateur Astronomers —
Beijing: Projecting into the Future, 201
Calendar of Events, 321, 433, 551
China: Astronomy in a Redeveloping Nation, 199
Drawing Mars in 1988, 429
H. B. Rumrill: An Amateur's Legacy, 86
International News, 433, 660
Jack Horkheimer: "Star Hustler," 544
Major Public Observatory Planned in Texas, 551
Mapping Mars, 431
StarTrails, 88, 203, 319, 432, 548, 659
U. S. News, 89, 320, 433
Washington Public Observatory Expands, 657
Women in Astronomy, 317

Astronomical Computing —
Bits and Bytes, 421, 651
Continued Fractions and the Sky, 80
Double Polestar of the Past, The, 531
Help for Star-Atlas Fumblers, 420
Jupiter and Its Mobile Moons, 650
New Concept in Computer-Aided Telescopes, A, 194
Refraction by Earth's Atmosphere, 311
Review Corner, 82, 422, 533
Sundial at Castle Howard, 81

Backyard Astronomy —
Star-Hop from Capella, A, 140
Star-Hop Through Ophiuchus, A, 603
Time and the Amateur Astronomer, 378

Books and the Sky —
Astrophysics of the Sun, Harold Zirin, 271
Astrowatch, Ben Mayer, 38
Briefly Noted, 42, 163, 272, 387, 503, 619
Coming of Age in the Milky Way, Timothy Ferris, 613
Constellations, The: An Enthusiast's Guide to the Night Sky, Lloyd Motz and Carol Nathanson, 498
Dark Matter, The, Wallace Tucker and Karen Tucker, 382
Dark Side of the Universe, The, James Trefil, 382
Essays About the Universe, Boris A. Vorontsov-Vel'yaminov, 157
Exploring the Night Sky, Terence Dickinson, 39
Gravity's Lens: Views of the New Cosmology, Nathan Cohen, 162
Introduction to Observing and Photographing the Solar System, Thomas A. Dobbins, Donald C. Parker, and Charles F. Capen, 36
Manual of Advanced Celestial Photography, A, Brad D. Wallis and Robert W. Provin, 612
New Patterns in the Sky, The, Julius D. W. Staal, 40
Peterson First Guide to Astronomy, Jay M. Pasachoff with Wil Tirion and Robin Brickman, 38
Planetary System, The, David Morrison and Tobias Owen, 270
Quantum Universe, The, Tony Hey and Patrick Walters, 39
Quickening Universe, The, Eugene F. Mallove, 156
Relatively Speaking: Relativity, Black Holes, and the Fate of the Universe, Eric Chaisson, 383
Resolute and Undertaking Characters: The Lives of Wilhelm and Otto Struve, Alan H. Batten, 380
Supernova 1987A: Astronomy's Explosive Enigma, Russell M. Genet, Donald S. Hayes, Douglas S. Hall, and David R. Genet, 501
Supernova Story, The, Laurence A. Marschall, 501
Telescope Optics: Evaluation and Design, Harrie Rutten and Martin van Venrooij, 614
Under Capricorn, David S. Evans, 502
Universe, The, Byron Preiss and Andrew Fraknoi, 159
Uranus and Neptune: The Distant Giants, Eric Burgess, 268

Celestial Calendar —
Afternoon Occultation for the South, An, 407
Asteroid Hebe in Cancer, 72
Binaries with Sunlike Stars, 294
Bright-Moon Regulus Occultation, A, 73
Calendar Notes, 74, 185, 296, 410, 525, 642
Colored Stars, 181
Comets This Month, 407
Crescent Moon Nicks the Pleiades, 405
Dawn Lunar Eclipse, A, 184
Jupiter's Satellites, 64, 178, 290, 402, 518
Lunar Occultation Highlights for 1989, 68
March 7th Partial Solar Eclipse, The, 292
Moonwatcher's Corner, 74, 185, 299, 412, 527, 643
New Dwarf Nova Soon To Erupt? 404
1989 Planet Preview, A, 66
Planetary Occultations of Stars in 1989, 70
Saturn To Occult a Bright Star, 638
Sun, Moon, and Planets This Month, The, 64, 178, 290, 402, 518, 636
Three Lunar Challenges, 520
Trio of Big Dipper Variables, A, 522
Venus in the Evening Sky, 525
Vesta near Saturn, Uranus, and Neptune, 296
Vigil for a Unique Stellar Eclipse, 180

50 & 25 Years Ago, 35, 126, 238, 350, 462, 582

Focal Point —
Affecting Eternity, 236
Cooperation in Space: The Real World, 4
Cosmic Correspondence, 348
In Defense of Casual Astronomy, 580
Let *Freedom* Ring! 460
Space Station *Freedom:* Bad News for Astronomy, 460
Turning Pro: The Good, the Bad, and the Ugly, 124

Front-cover photographs —
Great Star Wheel, 121
March's Super Aurora, 577
Neptune from Triton, 457
Prisms in the Sky, 233
Rat-tailed Galaxies, 1
Real Crab, The, 345

Gleanings for ATM's —
Amazing Stepper Motor, The, 554
Crawford-Dobsonian Mounting, The, 327
Design of Telescope Structures, The, — I, 97; II, 210
How I Made a Schmidt Camera, 664
"Lift-Off Roof" Observatory, A, 96
Optical Bench Talk, 101, 558
Simple Mount for the C90 Telescope, A, 441
So . . . You've Had a Bright Idea! 324
Two Arms Are Better Than One, 436

Images, 144, 248

Letters, 5, 125, 237, 349, 462, 581

News Notes —
Americans and Soviets Update Space Pact, 10
Antarctic Meteorites Reveal Ancient Ice, 466
Artist's Infrared Orion, An, 239
Astronomy Express, 14, 133, 247, 359, 470, 592
Astronomy in Orbit, 243
Automatic Telescopes To Ride the Space Station? 13
Black Heart of the Sombrero Galaxy, The, 12
British Astronomy Plans, 358
Capella as a Binary, 587
Cataloguing One Billion Stars and More, 351
Cosmology on Ice, 354
Crab and Kin, The, I: The Crab Shines On, 7; II: The Crabby Nebula, 8; III: The Helium Crab, 9
Crab Close Up, 586
Diamonds from Heaven and Earth, 244
Einstein's Ring and a Galaxy's Mass, 465
Eta Carinae Resolved, 353
Extragalactic Eta Carinae? An, 355
Gamma-Ray Confusion at the Galactic Center, 584
Giant Gas Ring "Weighs" Massive Halo, 587
Greater Pleiades Nebula, The, 128
Hex on Saturn, A, 246
High-Flying Astronomers Observe Supernova 1987A, 353
Hit, Miss, and Hope for Supernova Hunters, 468
Hot Nights on Venus, 245
Improvements for Arecibo, 467
Inside the Spinning Sun, 584
Invisible Galaxies? 13
It's Not the Sun, but the Moon, 469
Keck Dome Completed, 127
Laboratory Limits on Dark Matter, 131
Lost Pioneers? 590
Massive Antarctic Meteorite Found, 587
M83 in Ultraviolet Light, 465
Meteors from Asteroids, 245
Methane Rain on Titan? 246
Moon's Atmosphere, The, 589
Mount Graham Telescopes Get the Green Light, 130
Mysterious Flash Photographed on Moon, 468
No Go for Slow Flow, 10
Not-So-Great Attractor? The, 12
On the Trail of the Black Widow Pulsar, 128
Orion and the Swan: New Infrared Views, 352
Our Inconstant Star, 242
Phobos 2 Asks, "Is Mars Magnetic?" 464
Plateau de Bure Interferometer Takes Shape, 591
Pulsars in a Crowd, 127
Pulverized Asteroids and the Zodiacal Light, 242
Quasars and Radio Galaxies: In the Eye of the Beholder, 463
Radio Noise from Colliding Galaxies, 241
Reactors in Space Threaten High-Energy Astronomy, 464
Real Crab Nebula, The, 357
RGO Is Moving, 241
Scientific Illiteracy: The Movie, 586
Seeing Is Believing! 130
Seeking Missing Mass in Berkeley, 590
Shocks and Bubbles Around Hot Stars, 240
Sighting Comets with Radar, 239
Silicate Volcanism on Io . . . And Sulfur Volcanism on Venus, 355, 356
Sing the Asteroid Electric, 356
Soccer-Ball Molecules in Space, 358
Spectra Galore, 585
Spinning Meteors, 11
Starburst Milky Way, 589
Star Is Born, A, 588

Supernovae Galore, 129
Supernova 1987A: Fading Away, 127
Supernova Remnant on the Move, 244
Two of the Keck Mirror Segments Completed, 357
VLT Design Changes, 8
When a Red Giant Swallows Its Planets, 7
When the Sun Went Wild, 590
When Two Stars Become One, 239
Winged Rocket May Give Astronomy a Lift, 10
Woman's Place Is in the Dome, A, 590
World's Largest Impact Crater? 351
Wormholes, Time Machines, and Schrödinger's Cat, 132
Young Star's Active Jet, A, 9

Observer's Page —
Bowl Full of Galaxies, A, 444
Deep-Sky Wonders, 114, 227, 338, 450, 570, 683
February's Lunar Eclipse, 567
Gallery, 112, 224, 336, 448, 568, 680
How Faint Can You See? 332
Mars from Tennessee, 676
Photographing the Deep Sky Amid City Lights, 108
Portrait of a Year, 678
Sungrazing Comets: Big and Small, 564
Sunspot Numbers, 116, 228, 340, 451, 572, 684
Tuesday's Mail, 111
Watching Mars' Elusive Moons, 446
Watching the Sun, 220

Rambling Through the Skies —
Directions — Earth and Sky, 399
Planet Brightnesses, 629
Southern Sky's Attic, The, 515
Stargazing With Homer, 57
Stellar Teaching Tool, A, 287
To Bin or Not To Bin, 175

S&T Test Report —
Observatory from a Kit, An, 492
Running on Batteries, 266

Southern Stars for . . . (current month), 56, 286, 514

Stars for . . . (current month), 58, 176, 288, 400, 516, 630

Selected Topics and Celestial Objects

This listing is not intended to be exhaustive and does not supplant the other parts of the index. For example, material in such regular features as Books and the Sky is ordinarily indexed only under the Departments and Features section.

Amateur activities: accomplishments of Harry B. Rumrill, 86; Alabama observatory, 434; archaeoastronomy, 320; Astronomical League officers, 321; Astronomy Day, 89; Atlanta observatory, 89; Australia's National Association of Planetary Observers, 660; Austrian astrophotographer, 660; books for developing nations, 433; buying products, 548; in China, 199; *Comet Handbook*, 320; *Comet Rapid Announcement Service*, 433; computer program to find atlas chart number, 420; contributions to IAU *Circulars*, 423; Dial-a-Star, 90; Finnish international meeting, 434; *Handbook for Astronomical Societies 1989*, 660; in Hawaii, 90; International Meteor Organization meeting, 660; in Israel, 89; keeping an observing log, 659; long-term photographic projects, 676; Mars observations, 369, 429, 431, 432, 446; mentors, 236, 319; at Mount Wilson Observatory, 133; National Public Observatory, 551; newsletters wanted by U. S. Naval Observatory Library, 434; "no-guilt" astronomy, 580; notable achievements, 432, 684; observations of Phobos and Deimos, 446; observations with small telescopes, 88; at Pettinger-Guiley Observatory, 657; photographic Messier marathon, 338; *Planetarium Sourcebook*, 434; Planetfest '89, 434; proceedings of Paris meeting, 320; Public Astronomical Observatory, 433; Small Scope Observers Association, 320; *Sonne*, 433; Space Shuttle tours, 90; Spanish meeting, 433; "Star Date," 582; "Star Hustler," 544; *Teaching Space* newsletter, 89; types of amateur clubs, 203; visual magnitude estimates, 432; Voyager Watch, 434; in Washington, 657; white-light solar flare watch, 90; women amateurs, 317

Archaeoastronomy: Native American Sun-watching sites, 320

Art: by Heinrich Hansen, 146; by Ron Miller, 7; by Zaqueline Souras, 239; by Etienne L. Trouvelot, 148; Vincent van Gogh's *Road with Cypress and Star*, 237

Asteroids (minor planets): amateur involvement, 432; closest approach to Earth, 592; Earth-approaching and meteor streams, 245; families, 242; 1989 FC, 592; 724 Hapag recovered, 14, 432; heated by T Tauri wind, 356; 6 Hebe, 72; source of interplanetary dust, 242; 4 Vesta, 296

Astronomical constants: cosmological constant, 462; Hubble parameter, 10

Atlases and catalogues: magnitude representation, 175; National Geographic Society-Palomar Sky Survey catalogue, 351; program for calculating chart number, 420

Atmospheric phenomena: anticrepuscular rays, 258; calculating refraction, 311; field guide to, 254; glory, 258; green flash, 254, 258, 259; iridescent clouds, 257; rainbows and halos, 254; solar corona, 257; Sun pillar, 257

Auroras: electrons in Earth's magnetic field imaged, 130; Polar satellite to study, 133

Balloon astronomy: gamma-ray observations of galactic center, 584

Black holes: see ***Collapsed objects***

Chemistry: C_{60} molecules and "fullerenes," 358; of Neptune's atmosphere, 481; Venus' atmosphere, 356; Venus' surface, 360

Collapsed objects: black hole in M104, 12; black widow pulsar, 128; at center of Milky Way, 584; millisecond pulsars in globular clusters, 127; pulsar in SN 1987A, 359, 480

Comets: amateur discoveries, 432; Bradfield (1989c), 407; *Comet Handbook*, 320; *Comet Rapid Announcement Service*, 433; discovered by satellites, 566; dust trails, 243; Halley, 239; Ikeya (1963a), 260; Ikeya-Seki (1965 VIII), 564; IRAS-Araki-Alcock (1983d), 239; Levy (1988e), 432; Liller (1988a), 432; Machholz (1988j), 432; origin, 260; radar observations, 239; Shoemaker (1989e), 407; Shoemaker (1989f), 407; sungrazers, 564; Yanaka (1988r), 407, 432; Yanaka (1989a), 407, 432

Computing: almanacs for 1989, 422; analyzing sunspots and forecasting flares, 237; ancient polestar, 531; astronomy bulletin boards, 422; atmospheric refraction, 311; calculating atlas chart numbers, 420; C-language programs, 651; *Celestial Computing* journal, 652; continued fractions, 80; controlling altazimuth telescopes, 194; gear ratios, 80, 651; modeling galaxy interactions, 22; plotting Jupiter's moons, 650; precession and proper motion, 531; stereographic images, 421; supercomputer benchmarks, 421

Constellation study: de Lacaille and Keyser groups, 515; source book, 40; in southern sky, 515

Cosmic background radiation: observing from South Pole, 354, 601; observing from space, 593; solving Olbers' paradox, 594

Cosmology: anthropic principle, 6; expansion of universe, 10, 131, 462, 593, 594; galaxy-atom analogy, 462; Great Attractor, 12; Olbers' paradox, 594

Dark matter: dark galaxies, 13; halo around IC 2006, 587; limits of, 131; research center founded, 590

Detectors: echelle spectrograph, 585; gravitational-wave, 358; for Hubble Space Telescope, 133, 153; images from infrared, 352

Eclipses:

Lunar: February 20, 1989, total, 184

Solar: March 7, 1989, partial, 292; viewing safely, 292; weather prospects for July 11, 1991, total, 134

Education: books wanted for developing nations, 433; career in astronomy, 124; explosion of astronomical publications, 470; Project STAR, 586; scientific illiteracy movie, 586; "Spacial Education Awards," 89; "Star Date" radio program, 582; "Star Hustler" TV show, 544; *Teaching Space* newsletter, 89

Galaxies: in bowl of Big Dipper, 444; dark, 13; dark halo around IC 2006, 587; DDO 154, 13

Active: international watch for active galactic nuclei, 14; NGC 5256 (Markarian 266), 241; same object as quasars? 463; triggered by interaction, 18

Interacting: Arp 220, 21; Arp objects, 20; computer modeling of, 22; NGC 3690-IC 694, 24; NGC 4038-39, 22; NGC 5256 (Markarian 266), 241; NGC 5754-55, 25; NGC 6240, 18; overview of, 18

Milky Way: center, 584; starburst phase, 589

"Normal": M101, 570; M104 (Sombrero), 12; NGC 1023, 114; NGC 1058, 115; NGC 1130, 115; NGC 1275, 115; NGC 2469, 228; NGC 2474, 227; NGC 2475, 227; NGC 2667A, 451; NGC 2667B, 451; NGC 2672, 450; NGC 2673, 450; NGC 2677, 451; NGC 3185, 451; NGC 3190, 451; NGC 3193, 451; NGC 3610, 444; NGC 3613, 444; NGC 3619, 444; NGC 3642, 444; NGC 3683, 444; NGC 3683A, 444; NGC 3690, 444; NGC 3780, 444; NGC 3804, 444; NGC 3846, 445; NGC 3846A, 445; NGC 3850, 445; NGC 3888, 444; NGC 3898, 444; NGC 3913, 445; NGC 3916, 445; NGC 3921, 445; NGC 3958, 445; NGC 3963, 445; NGC 3972, 445; NGC 3977, 445; NGC 3982, 445; NGC 3990, 445; NGC 3998, 445; NGC 5660, 684; NGC 5676, 684; NGC 5866, 571; NGC 5907, 571; NGC 5976, 683; NGC 5976A, 683; NGC 5981, 683; NGC 5982, 683; NGC 5985, 683; NGC 6015, 683; NGC 6384, 604; NGC 6503, 572; supernovae in NGC 253, 129

Gamma-ray astronomy: from center of Milky Way, 584; nuclear reactors and "gamma-ray pollution," 464

Gravitation: British planned detector, 358; Einstein ring, 465

H I regions: dark halo around IC 2006, 587

H II regions: newborn stars in Cepheus A and Cygnus, 588

Herbig-Haro objects: 9

History: Ahnighito meteorite recovery, 350; Chaucer and Moon, 376; crucifixion of Jesus, 374; Messier's "missing" objects, 570; Neptune's ring, 610; Olbers' paradox, 594; Peary North Pole controversy, 57, 350; science at the South Pole, 598; sighting zodiacal light, 146; skies of Homer, 57; Southern Hemisphere astronomy, 502; southern-sky constellations, 515; Struve legacy, 380; sungrazing comets, 564; visual observations of Neptune, 486, 610

Image processing: and the eye, 125

Infrared astronomy: Io and volcanism, 356; Mars, 133; M17 and M42, 352; Pleiades, 128; Titan, 246; Venus, 245; zodiacal dust bands, 242

Interferometry: Merlin array, 358; Plateau de Bure array, 591; Very Long Baseline Array link, 470

Interplanetary matter: gegenschein, 147; zodiacal light, 147, 242

Interstellar matter: interaction with hot stars, 240

Light pollution: small victory in Pittsburgh, 583

Masers: silicon dioxide in red giants, 7

Meteorites: Ahnighito recovery, 350; in Antarctica, 466, 587; Baton Rouge fall, 126; diamond grains, 244; largest impact crater, 351; from Mars, 473

Meteors: and Earth-approaching asteroids, 245; International Meteor Organization, 660; nonlinear, 11, 237; spinning, 11

Molecular clouds: active jet in, 9

Molecules: C_{60} and "fullerenes," 358

Moon: change in length of month, 469; craters named for astronauts, 265; and dating crucifixion, 374; features challenging to view, 520; lunar speed, 376; lunar transient phenomena, 468; sodium in exosphere, 589; tides and ancient sediments, 469; very young, 349, 373

Nebulae:

Bright: Crab lookalike 3C 58, 8; IC 1805 and 1848, 248; infrared views, 352; M1 (Crab), 7, 9, 586; M17 (Omega), 352; M42 (Orion), 352; NGC 1491, 142; NGC 1624, 142; Southern Crab, 357

Planetary: NGC 6543, 571; NGC 6572, 605; PK 164 + 31.1, 227

Neutrino astronomy: supporting relativity, 247

Neutron stars: see ***Collapsed objects***

Novae: amateur discoveries, 432; dwarf, 404; FSV 113211 to erupt soon? 404

Observatories (amateur and public): Atlanta Astronomy Club, 89; at Beijing Planetarium, 201; Chandler's lift-off roof, 96; Climax, 320; Hexadome observatory kit, 492; National Public, 551; Pettinger-

Guiley, 657; Pine Lake, 434; Public Astronomical, 433; Temple, 320

Observatories (professional): Arecibo, 467; Byurakan Astrophysical, 133; Carnegie Institution name change, 359; European Southern, 8, 470; Kuiper Airborne, 353; Mount Graham, 130, 592; Mount Wilson saved, 133; Pulkovo, 381; Royal Greenwich move, 241; at South Pole, 598; Sydney, 502

Observing techniques: keeping an observing log, 659; limiting magnitude chart, 332; for Saturn occultation, 639

Occultations: April 8, 1989, lunar, of Pleiades, 405; April 15, 1989, lunar, of Regulus, 407; January 23-24, 1989, lunar, of Regulus, 73; revealing Neptune's ring arcs, 606; of 28 Sagittarii by Saturn, rings, and Titan, 638

On-line databases and communications (see also Computing): AppleLink, 421; astronomy bulletin boards, 421, 422

Optics: parfocal standard for eyepieces, 558; for Schmidt camera, 664; testing for telescopes, 614

Organizations: Astronomical League, 321; British Astronomical Association's Section for the Observation of the Colours of Stars, 181; Australia's National Association of Planetary Observers, 660; International Meteor Organization, 660; National Space Society shuttle tours, 90; Planetary Society, 434; Small Scope Observers Association, 320

People: Banneker, B., 583; Byrd, D., 318; Chambers, G. F., 181; Chaucer, G., 376; de Lacaille, N. L., 515; Franks, W. S., 181; Fraunhofer, J., 251; Galeev, A. A., 14; Gill, J. R., 236; Homer, 57; Horkheimer, J., 544; Keyser, P. D., 515; Kunkel, L., 318; Lassell, W., 610; Moran, D., 317; Olbers, H., 594; Rumrill, H. B., 86; Peary, R. E., 57; Peltier, L., 6; Sabatini, D., 317; Struve, O., 380; Struve, W., 380; Todd, D. P., 5; Williamson, I. K., 319

Photography: advanced celestial, 612; analemma, 678; building a Schmidt camera, 664; modern trends, 111; Phobos and Deimos, 446; photographic Messier marathons, 338; retrograde loop of Mars, 676; urban deep-sky, 108; versus CCD images of Mars, 350

Physics: neutrinoless double beta decay, 131; supernova tests relativity, 247; wormholes for interstellar travel, 132

Planetariums: Beijing, 201; *Planetarium Sourcebook*, 434

Planets and their satellites: brightnesses of, 629; comparisons of magnetospheres, 149

Earth (see also Moon): change in length of day, 462, 469; diamonds and age of, 244; magnetosphere, 149; tracing magnetic field, 130

Jupiter: magnetosphere, 149; volcanism on Io, 355

Mars: amateur drawings, 429, 431; atmosphere, 475; best ground-based images, 15, 349, 350, 471; carbon dioxide in surface rocks, 133; color, 474; composition of, 473; magnetosphere, 149, 464; maps of Phobos, 477; and meteorites, 473; mosaic of Candor Chasma, 144; no water in satellites, 470; observations of 1988 apparition, 30, 369, 429, 432, 446, 471, 476, 676; observations of Phobos and Deimos, 446, 592; Phobos spacecraft, 359, 464, 470, 592; photographing retrograde loop, 676; photographs versus CCD images, 350; on video, 476

Mercury: magnetosphere, 149

Neptune: characteristics, 481; magnetosphere, 149, 483; mistaken ring, 610; ring arcs, 606; Triton and Nereid, 484; visual observations, 486, 610

Pluto: and Charon, 583; perihelion reached, 67

Saturn: hexagonal feature, 246; magnetosphere, 149; methane rain on Titan? 246; occultation of 28 Sagittarii, 638

Uranus: magnetosphere, 149; Miranda, 269

Venus: evening apparition, 525; geology, 360; infrared views, 245; magnetosphere, 149; radar imagery, 360; topography, 360; volcanism, 356, 366

Pulsars: see ***Collapsed objects***

Quasars: Einstein ring, 465; same object as radio galaxies? 463

Radar astronomy: comets, 239; Venus, 360

Radio astronomy: dark matter, 587; Einstein ring of quasar, 465; red-giant silicon dioxide masers, 7; star-formation regions, 588

Relativity: supernova neutrinos as test for, 247

Rocket astronomy: imaging Earth's magnetic field, 130; M83 in ultraviolet light, 465

Science policy: British astronomy plans, 358; global network of automatic telescopes, 143; National Academy of Sciences survey for astronomy in 1990's, 470; replacing 300-foot radio telescope, 252, 470

Space-based astronomy: automatic photoelectric telescopes on space station, 13; detectors for Hubble Space Telescope, 133, 153; infrared view of Pleiades, 128; list of satellites, 243; nuclear reactors and "gamma-ray pollution," 464; sungrazing comets, 133, 564

Spacecraft: Cassini, 14; Cosmic Background Explorer, 592, 593, 597; Gamma-Ray Observatory, 464; Ginga, 464; Hubble Space Telescope, 133, 153; Infrared Astronomy Satellite, 128, 242; International Sun-Earth Explorer 3, 247; list of astronomical, 243; Magellan, 360, 367; orbiting nuclear reactors, 464; Phobos 2, 247, 359, 464, 470, 592; Pioneer 10 and 11, 590; Pioneer Venus, 361; Polar satellite, 133; Solar Maximum Satellite, 133, 566, 590, 592; Solar Mesospheric Explorer lost, 592; Solwind, 566; Space Station *Freedom*, 460; Ultraviolet Imaging Telescope, 465; using shuttle external tanks for scientific studies, 133; Vega 1 and 2, 362; Veneras to Venus, 360; Voyager 2, 481, 484, 609

Space policy: astronomy on the space station, 460; of European Space Agency, 14; international cooperation, 4; joint American-Soviet pact, 10

Star clusters:

Associations: Alpha Persei, 142

Globular: NGC 2419, 227; NGC 5466, 684; pulsars in, 127

Open: IC 2157, 340; IC 4665, 604; IC 4756, 605; M35, 339; M44 (Praesepe), 450; M67, 332; NGC 957, 114; NGC 1513, 142; NGC 1528, 142; NGC 1545, 142; NGC 1582, 141; NGC 1664, 141; NGC 2158, 340; NGC 6633, 605; Pleiades in infrared, 128

Stars: active births, 9; age of nearby solar-type, 589; colors, 181; large formation regions, 588; proper motion, 287; red, 182; red giant, 7; supermassive, 353

Double and multiple: Capella, 587; Eta Carinae, 353; Castor, 338; Alpha Comae Berenices, 180; Alpha Herculis, 603; interacting pairs, 239; Iota Leonis, 295; mergers, 239; 53 Ophiuchi, 604; 70 Ophiuchi, 605; Sirius, 287; Struve 1104, 294; with sunlike stars, 294; 78 Ursae Majoris, 295; vividly colored, 183

Individual: Barnard's star, 605; Alpha Ophiuchi, 603

Variable: Alpha Comae Berenices, 180; dwarf novae, 404; FSV 113211, 404; Alpha Herculis, 603; Mira-type, 7; RS Ursae Majoris, 522; S Ursae Majoris, 522; T Ursae Majoris, 522; W Ursae Majoris, 239

Sun: flare cycle? 247; flare watch, 90; flares, 271, 494, 590; forecasting flares with a computer, 237; German solar-observing newsletter, 433; helioseismology, 584, 598; heliosphere, 152; internal rotation, 584; observing, 220; observing from South Pole, 598; photographing analemma, 678; spectrum, 585; sunspot-weather link rejected, 469; surface temperature differences, 242; T Tauri wind and asteroids, 356

Sundials: vertical at Castle Howard, 81

Supernovae: of A. D. 1006 in Lupus, 244; of A. D. 1181, 8; amateur discoveries, 432, 468; S Andromedae remnant, 247; Berkeley automatic search, 468; "Eta Carinae" outburst, 355; Cassiopeia A, 502; extragalactic, 129; making cosmic diamond grains, 244; pulsar in SN 1987A, 359, 480; remnants, 7, 8, 9, 244, 247; SN 1961V, 355; SN 1987A, 127, 247, 353, 359, 480; SN 1989A, 468; SN 1989B, 468; testing relativity, 247; Type V outburst, 355

Tektites: moldavites, 351

Telescope making: applying for a patent, 324; battery pack, 266; booklet for building Dobsonians, 559; building for less than $500, 26, 488; building a Schmidt camera, 664; computer-controlling altazimuth telescopes, 194; double-arm drives, 436; equatorial motion with a Dobsonian, 327; improved stepper motor, 554; large lightweight mirrors, 559; mount for C90, 441; structural analysis and mechanical stability, 97, 210

Telescopes (amateur): Atlanta Astronomy Club's 20-inch reflector, 89; Mitton's 10-inch reflector, 488; Schultz, Kuehl, and Lundegard's 8-inch reflector, 26

Telescopes (professional): Anglo-Australian (3.9-meter), 585; Arecibo upgrading, 467; automatic on space station, 13; Bruce astrograph lookalike, 238; Columbus Project Binocular, 130; Dorpat refractor (9½-inch), 250; global network of automatic telescopes, 143; Green Bank 300-foot, 14, 252, 470; Keck (10-meter), 127, 357; New Technology Telescope (3.58-meter) first light, 470; partnerships for Hale (200-inch), 14, 470; Vatican Advanced Technology Telescope (1.8-meter), 130; Very Large Telescope (16-meter), 8; WIN telescope (3.5-meter), 133

Timekeeping: corrections for location, 59, 378; in astronomy, 378; using continued fractions, 80

Ultraviolet astronomy: M83, 465

Vision: limiting magnitude test, 332; safety for solar eclipse viewing, 292; sensitivity of the eye, 125

X-ray astronomy: solar flares, 590